
THE REAPPEARANCE OF THE TILEFISH.

BY HERMON C. BUMPUS, PH. D.,

Director of Biological Laboratory of United States Fish Commission.

During the past summer the investigations of the United States Fish Commission have brought to light the facts that the tilefish (*Lopholatilus chamaeleonticeps*), once supposed to be extinct, occurs in great numbers off the southern coast of New England, and that its capture requires only the ordinary apparatus used in cod and haddock fishing. This fish possesses excellent food qualities and its reappearance may result in the development of an industry of considerable importance. Its history is of scientific interest, since it furnishes evidence that life on the sea bottom is subject to periodic modification, and that a species almost annihilated may become quickly reestablished.

In May, 1879, Captain Kirby, of Gloucester, in command of the schooner *William V. Hutchins*, while searching for cod and hake almost directly south of Nantucket, caught great numbers of a "strange and handsomely colored fish." The first catch, of nearly 2,000 pounds, was made in water varying from 80 to 120 fathoms in depth, at latitude 40° 04' N., longitude 70° 23' W. Four trawls were used, each about a mile in length, and bearing 1,000 hooks. Nearly all of these fish were thrown overboard, but a few were kept and cooked.

Captain Kirby stated that they were the finest fish he had ever eaten, and he determined to save and salt all that he might catch. The trawls were set the same day in latitude 40° 04' N.; longitude 70° 17' W., and again in latitude 40° 00' N., longitude 70° 04' W. Both sets yielded about 2,000 pounds of dressed fish, which, on being landed in Gloucester, were sold to Messrs. Friend & Son, who disposed of them in various ways.

Captain Kirby sent one of the fish to the United States National Museum, where it was examined by Messrs. Goode & Bean, and described (Proceedings U. S. Nat. Mus., vol. II, pp. 205-208) as a new genus and species (*Lopholatilus chamaeleonticeps*). Recently it has been assigned by Jordan & Evermann to the family *Malacanthidae*, a group of fishes of somewhat obscure relationship, found in temperate and tropical seas.

In July of the same year Captain Dempsey, also of Gloucester, caught 9 tilefish while fishing for cod in a locality 50 miles south by east of No Man's Land, in 75 fathoms of water.

Professor Baird took great interest in the discovery of this new fish. Its fine flavor and attractive appearance indicated excellent marketable qualities, and its great abundance promised to be a profitable source of income to offshore fishermen.

The *Fish Hawk* took 3 specimens on the 13th of September, 1880, in 126 fathoms, latitude $39^{\circ} 57'$ N., longitude $70^{\circ} 56'$ W., and so anxious was Professor Baird to gain additional information that he chartered the fishing smack *Mary Potter*, of Noank, in which Mr. Vinal Edwards left Newport for the tilefish grounds on the 29th of September. A trawl line of 400 hooks, baited with menhaden, was set in 127 fathoms, but only a swordfish and two skates were caught. Threatening weather then drove the vessel back to port.

On August 9, 1881, trawl lines were set from the *Fish Hawk* in 134 fathoms, latitude $40^{\circ} 02'$ N., longitude $71^{\circ} 12'$ W., and 8 tilefish, weighing 147 pounds, were taken. On August 23, in latitude $40^{\circ} 03'$ N., longitude $70^{\circ} 31'$ W., 73 fish, weighing 540 pounds, were taken. The trawl line was set again on September 21 at a point farther to the eastward, latitude $39^{\circ} 58'$ N., longitude $70^{\circ} 06'$ W., in water of 113 fathoms, but no fish were taken.

In March and April, 1882, vessels entering New York and other Atlantic ports reported that they had passed through countless numbers of dead fish while crossing the northern edge of the Gulf Stream. Investigation proved that these were tilefish, and that they appeared on the surface of the water over an area of 170 miles in length and 25 miles in width. A conservative estimate, made by Capt. J. W. Collins (Fish Commission Report for 1882), who has given a detailed history of the tilefish up to the time of this mortality, placed their number at upwards of 1,438,720,000. Allowing 10 pounds to each fish, he has estimated that there would be 288 pounds of fish for every man, woman, and child in the United States.

In September, 1882, Professor Baird chartered the *Josie Reeves*, and sent her to the tilefish grounds, that he might ascertain to what extent the species had been depleted, but the vessel returned without having found a single individual. This seemingly unprecedented destruction of marine life was extensively commented upon both by newspapers and scientific journals, and in the Report of the U. S. National Museum for 1889 the tilefish was placed, provisionally, in a list of extinct animals.

The scientific work that finally led to the rediscovery of the animal really began in the summer of 1880, when the completion and equipment of the *Fish Hawk* made it possible to enter upon lines of investigation which before were out of the question. This vessel has added materially to the practical efficiency of the Commission, and its frequent employment by men of science has greatly increased our knowledge of oceanic life.

In November, 1880, Professor Verrill published his memorable "Notice of the remarkable marine fauna occupying the outer banks of the southern coast of New England" (Am. Jour. Sci., Nov. 1880, p. 390), in which he gave the scientific results of three excursions made by the *Fish Hawk*. On these excursions the dredge was used 23 times, and an enormous number of deep-sea animals were taken. Among these were 130 species of mollusks, 26 echinoderms, 43 crustacea, and 16 fish new to the southern coast of New England, and many of these animals were also new to science.

During the following summer, 1881, seven excursions were made to the Gulf Stream, where, besides the work done with the line trawl already mentioned, the

dredge was used 47 times. It is fortunate that these investigations were made in 1880 and 1881, since they furnished definite data respecting the physical and biological conditions of a tract of the sea bottom which in the spring of 1882 became the scene of widespread devastation.

While Captain Collins was collecting his data, the *Fish Hawk*, which had taken a few tilefish in 1880, and had found them very numerous in 1881, was continuing her deep-sea explorations under the direction of Professor Verrill. During August, September, and October, 1882, five trips were made to the tilefish grounds, and the dredge was lowered 46 times. The definite information relative to the life on the sea bottom, which Professor Verrill had been able to secure during the summers of 1880 and 1881, now became of great value, since it enabled him to report on the general faunistic changes which had affected this area, to measure the extent of the destruction of oceanic life, and to give an intelligent reason therefor.

In the report for 1882, he writes:

One of the most peculiar facts connected with our dredging this season (1882) was the scarcity or absence of many of the species, especially crustacea, that were taken in the two previous years, in essentially the same localities and depths, in vast numbers, several thousand at a time.

In another article (Physical characters of the portion of the continental border beneath the Gulf Stream, explored by the *Fish Hawk*, 1880 to 1882), Professor Verrill describes the rapid incline of the sea bottom beyond the 100-fathom line, "usually as steep as the side of a great mountain chain, and about as high as Mount Washington, New Hampshire." He further writes:

The bottom along the upper part of this slope and the outermost portion of the adjacent plateau, in 65 to 150 fathoms, and sometimes to 200 fathoms or more, is bathed by the waters of the Gulf Stream. Consequently the temperature of the bottom water along this belt is decidedly higher than it is along the shallower part of the plateau near the shore, in 25 to 60 fathoms. * * * We may therefore call the upper part of the slope, in about 85 to 150 fathoms, the "warm belt."—(Report U. S. Fish Commission for 1882, p. 279.)

It was along this warm belt that many animals characteristic of tropical or sub-tropical fauna were dredged in 1880 and 1881, and Professor Verrill states:

In fact, this belt is occupied by a northern continuation of the southern or West Indian Gulf-Stream fauna * * * that could not exist there if the Gulf Stream did not flow along this area at the bottom, both in winter and summer.

The tilefish, whose relatives are known to be tropical, doubtless belongs to this warm-water fauna, and the destruction of 1882 was explained by Professor Verrill when he wrote, in October of that year:

It is probable, therefore, that the finding of vast numbers of dead tilefish floating at the surface in this region last winter was connected with a wholesale destruction of the life at the bottom, along the shallower part of this belt (in 70 to 150 fathoms), where the southern forms of life and higher temperature (47° to 52°) are found. This great destruction of life was probably caused by a very severe storm that occurred in the region at that time, which, by agitating the bottom water, forced outward the very cold water that even in summer occupies the wide area of shallower sea in less than 60 fathoms along the coast, and thus caused a sudden lowering of the temperature along this narrow warm zone, where the tilefish and the crustacea referred to were formerly found.

The warm belt is here narrow, even in summer, and is not only bordered on its inner edge, but is also underlaid in deeper water by much colder water. In fact, the bottom water inshore is probably below 32° F. in winter where the depth is 20 to 40 fathoms. In August this year (1882) we found the temperature 37° F., south of Cape Cod, in 55 to 60 fathoms. It is evident, therefore, that even a moderate agitation and mixing up of the warm and cold water might in winter reduce the temperature so much as to practically obliterate the warm belt at the bottom. But a severe storm, such as the one

referred to, might even cause such a variation in the position and direction of the tidal and other currents as to cause a direct flow of the cold inshore waters to temporarily occupy the warm area, pushing farther outward toward the Gulf-Stream water. The result would in either case be a sudden and great reduction of temperature, perhaps as much as 15° to 20°. This could not fail to be very destructive to such southern species as find here nearly their extreme northern limits. It is probable, however, that these southern species, including the tilefish, were not thus destroyed farther south. Therefore it is probable that in a few years they will again occupy these grounds by migrating northward, even if there be not enough left here to replenish their races.—(Report of the United States Fish Commission, 1882, p. 279.)

These quotations are here inserted because they are based on facts ascertained by those interested in the scientific work of the Commission and because they explain adequately the cause of the mortality, ascribing it to climatic changes.*

In 1883 the *Fish Hawk* made but one excursion to the Gulf Stream, and even then did not reach the edge of the "warm belt," the deepest water in which the dredge was cast being only 62 fathoms. The *Albatross* worked on the ground, however, and cast the dredge at least 20 times over the area known to have been occupied previously by the tilefish. Since 1883, up to the present time (January, 1899), the *Fish Hawk* has not again attempted to explore this portion of the sea bottom.

In 1884 the *Albatross* made a most careful survey of the "tilefish grounds" and the tracts of deeper and shallower water bounding the same. The dredge was lowered 76 times, and although material of great scientific interest was secured, no trace of the tilefish was found.

In 1885 the examination of the sea bottom in this locality was continued, and the dredge was lowered from the *Albatross* 38 times.

In 1886 the *Albatross* lowered the dredge 14 times, but no tilefish were found.

It is worthy of note that the first cruise made by the Fish Commission schooner *Grampus* was to the tilefish grounds. The vessel left Newport on August 14, 1886, and set trawls in 96 fathoms (latitude 39° 59' N., longitude 70° 15' W.), and although trawls and hand lines were repeatedly used until August 21 the ground was so barren that only a few hake were taken. The stomachs of these fish showed a scarcity of food suitable for the *Lopholatilus*, and Captain Collins concluded that—

It is safe to say that the large number of sets made with the trawl line on this occasion, together with the trials made with hand lines, clearly demonstrate the fact that if the tilefish has not become absolutely extinct in this region it is certainly so rare that the chances of obtaining it are limited.

In 1887 the *Albatross* made three unsuccessful efforts to find the tilefish, and in November left the Atlantic waters and sailed to the Pacific, where she has remained.

In 1888 no attempt was made to visit the tilefish ground.

In 1889 Prof. William Libbey, jr., began a series of temperature and specific-gravity observations off the shore of southern New England, which extended directly over this interesting tract. These observations were made for the purpose of "establishing some connection between the changes in temperature in the waters and the migrations of the fish which inhabit them." The *Grampus* was placed at the disposal of Professor Libbey, and an account of his work for the summer of 1889 will be found

* Professor Libbey, in a paper read before the Geographical Congress in 1895, claims that the effect of any single storm is largely superficial, and that it takes the resultant of several years of storms permanently in one direction or the other to produce such effects in deep water. Professor Libbey ascribes the disappearance of the fish to conditions just the reverse of those mentioned by Professor Verrill, namely, the cold body of water on the continental platform was allowed to advance over the area upon the edge of the continental plateau by a retrogression of the warm waters of the Gulf Stream produced by the exact opposite of the conditions which caused its advance toward the same edge.

in the U. S. Fish Commission Bulletin, vol. IX. This account contains a record of over 1,600 temperature observations, and the general results were of such importance that Commissioner McDonald continued the work during the summer of 1890, at which time the United States Coast Survey steamer *Blake* was detailed to act in cooperation with the *Grampus*.

During the summer of 1891 the *Grampus* was placed again at the disposal of Professor Libbey, and the work was continued along the same lines as during the two previous years. Unfortunately, the results of these investigations, perhaps the most complete ever conducted over a tract of the ocean of equal extent, have never been published, although they yielded extremely important data relative to the physical changes affecting the sea and the sea bottom. Professor Libbey found that a comparison of the temperature records as shown by the temperature cross-sections constructed upon the basis of the observations made in this body of water for the three years 1889, 1890, and 1891, demonstrated that there had been a progressive movement of the warm water, of 50° temperature, toward the shore.

In a communication addressed to Commissioner McDonald in 1892, Professor Libbey wrote:

In 1889 the lower portion of the curve did not touch the edge of the continental platform at any point within the area we were studying. In 1890 this portion of the curve touched the continental edge both at Block Island and off Nantucket Island in the latter part of the season; and in 1891, as has been said, it touched along the whole edge of this portion of the platform during the greater part of the summer. The change which was thus produced in the temperature at the bottom along this edge of the continental platform was in the neighborhood of 10°, an item of considerable importance.—(Report U. S. Fish Commission, 1893, p. 34.)

Professor Libbey, in a conference with Commissioner McDonald, showed that if the movement of the warm band toward the shore continued during the summer of 1892, the whole of the continental edge, or that part of it upon which the tilefish had once flourished, would present environmental conditions favorable to the return of the fish. The importance of these presentations was recognized by Commissioner McDonald, and though other work had been laid out for the *Grampus*, she was ordered to prepare for further explorations of the Gulf Stream and the bottom fauna off the southern New England coast. Professor Libbey writes:

In July the Commissioner and myself went out in the schooner *Grampus*, south of Martha's Vineyard, to the area which seemed to promise a reward for our labors. We found the temperature conditions right, set the cod trawls, and caught the tilefish. During the remaining portion of the summer I spent considerable time tracing out the limits of the area over which the temperature of 50° and above could be found, using the trawl lines at the same time to ascertain if the fish were there. We found them all the way to the Delaware capes, and were satisfied that, though they were not numerous, they had taken advantage of the changed conditions to occupy the area.

It is thus seen that whereas Professor Verrill in 1882 had given reasons for the disappearance of the fish, and had stated that, "It is probable that in a few years they will occupy these grounds by migrating northward, even if there be not enough left here to replenish their race," and although an indiscriminate search of ten years had failed to find any trace of the lost fish, the results of Professor Libbey's temperature investigations enabled him to show that the physical conditions of the sea bottom were variable, to prove that there was a definite movement of warm water toward the area earlier occupied by the tilefish, and to predict that if this movement continued the tilefish would be found again in its old habitat.

Eight specimens of tilefish were taken by the *Grampus* in 1892, as indicated in the following table:

Date.	Station No.	Depth.	Lat. N.	Long. W.	No. of tilefish.	Weight.
Trip 1:		<i>Fms.</i>	° ' "	° ' "		<i>Lbs.</i>
Aug. 5, 1892 ...	1	75	40 04 00	70 27 00	.....	.....
Aug. 5, 1892 ...	2	70	40 01 00	70 35 00	.....	.....
Aug. 6, 1892 ...	3	98	40 02 00	70 38 00	.....	.....
Aug. 6, 1892 ...	4	74	40 06 30	71 00 00	1	7
Aug. 6, 1892 ...	5	76	40 05 00	71 04 00	.....	.....
Trip 2:						
Aug. 11, 1892 ...	6	84	40 06 00	71 00 00	.....	.....
Aug. 13, 1892 ...	7	108	39 57 00	71 32 00	.....	.....
Aug. 13, 1892 ...	8	91	40 01 00	71 25 00	.....	.....
Trip 3:						
Aug. 18, 1892 ...	9	78	40 08 00	71 08 00	1	13
Aug. 18, 1892 ...	10	82	40 00 00	71 24 00	.....	.....
Aug. 19, 1892 ...	11	51	40 05 00	71 23 00	.....	.....
Aug. 20, 1892 ...	12	78	40 02 00	71 28 00	.....	.....
Trip 4:						
Sept. 7, 1892 ...	13	84	39 36 00	71 46 30	.....	.....
Sept. 9, 1892 ...	14	79	39 44 30	71 58 00	.....	.....
Sept. 10, 1892 ...	15	90	39 34 00	72 06 00	.....	.....
Sept. 10, 1892 ...	16	58	39 38 00	72 16 00	.....	.....
Trip 5:						
Sept. 17, 1892 ...	17	58	39 40 00	72 34 30	.....	.....
Sept. 17, 1892 ...	18	65	39 30 00	72 28 00	.....	.....
Sept. 17, 1892 ...	19	74	39 26 00	72 22 30	1	(?)
Sept. 18, 1892 ...	20	75	39 20 00	72 27 30	3	(?)
Sept. 18, 1892 ...	21	95	39 28 00	72 11 00	.....	.....
Trip 6:						
Oct. 3, 1892 ...	22	72	38 09 00	73 55 00	.....	.....
Oct. 7, 1892 ...	23	67	38 25 00	73 36 00	.....	.....
Oct. 8, 1892 ...	24	70	38 40 00	72 58 00	2	(?)
Oct. 8, 1892 ...	25	85	38 52 00	72 58 00	.....	.....
Oct. 9, 1892 ...	26	100	39 07 00	72 45 00	.....	.....

Two of the stations (4 and 9) at which tilefish were taken are located on the original tilefish ground, at a point that had not been tested by either the *Fish Hawk* or the *Albatross*, although the latter vessel in 1883 dredged within 7 miles of this spot, and in 1886 Captain Collins used trawls still nearer. The other stations at which the fish were found (19, 20, and 24) were considerably farther to the west, a locality that had been examined by the *Albatross* in 1883 and again in 1884. This locality, near the great submarine channel which cuts through the continental shelf from the mouth of the Hudson to the deep water underlying the Gulf Stream, was the seat of continued investigations during the following season.*

The reasons for the movements of the *Grampus* in 1892 and 1893 are stated in a communication from Professor Libbey, bearing date April 3, 1899, in reply to certain questions which I had asked.

"With regard to the capture of the tilefish (in 1892), to the westward of the positions where my observations had been made, I would say that the facts which have been published cover only a small amount of the items which are to be derived from a careful and systematic study of the temperature observations. When in Washington, at the time of the conference with Colonel McDonald, I told him that if the tilefish were of a tropical form he might expect to find the fish that year, provided the conditions I anticipated were fulfilled at one of two points, and I marked the positions on a map in his office—one of them being off the Delaware capes, the other south of Martha's Vineyard—and I gave as my reasons that I felt quite sure that the break or depression in the continental edge, representing the bed of the Hudson River, was of such a character and depth as to prevent the tilefish from crossing it, unless the high temperature had proceeded far enough inland, or in toward the land, to make a connection across the upper part of this depression. If you will examine the charts of the Coast Survey you will find that there is a somewhat remarkable depression on the edge of the continental platform to the southeast of the mouth of the Hudson River. It was my idea that a band of warm waters moving in from the southeast would touch this platform; but as the tilefish apparently was a bottom fish, the migration of the school would stop if the temperature variations did not touch the bottom clear around this depression. If such were the case, the fish would be found off the Delaware capes only; but if the connection had been made the fish would probably be found in both places.

"When we succeeded in finding the fish in the area where my observations had been made, I immediately suggested to Colonel McDonald that we follow up the edge of the continental platform,

In 1893 the *Grampus* made five trips in search of the tilefish, set the trawls at 18 stations, and caught 53 fish. Although the trawls were set at 5 places near stations 4 and 9, no fish were taken, so that the greater amount of time was spent near the "Hudson Channel," where on one occasion a single set of the trawl yielded 24 fish.

The record for 1893 is as follows:

Date.	Station No.	Depth.	Lat. N.	Long. W.	No. of tilefish.	Weight.
Trip 1:		<i>Fms.</i>	° ' "	° ' "		<i>Lbs.</i>
July 19, 1893...	27	93	39 58 00	71 19 00	.....	.....
July 20, 1893...	28	75	39 15 00	72 31 30	.....	.....
July 20, 1893...	29	86	39 14 00	72 29 00	.....	.....
July 21, 1893...	30	78	39 23 00	72 24 00	1	4
July 21, 1893...	31	74	39 23 00	72 25 00	2	.....
July 21, 1893...	32	71	39 22 00	72 24 30	1	.....
Trip 2:						
July 25, 1893...	33	70	39 25 00	72 27 00	1	.....
July 27, 1893...	34	74	39 20 00	72 28 00	.....	.....
July 27, 1893...	35	69	39 25 00	72 19 00	*4	.....
Trip 3:						
Aug. 10, 1893...	36	79	39 19 30	72 25 30	1	.....
Aug. 11, 1893...	37	73	39 20 00	72 28 45	†24	.....
Trip 4:						
Aug. 10, 1893...	38	72	39 23 00	72 32 00	6	.....
Aug. 20, 1893...	39	72	39 23 00	72 29 00	7	.....
Aug. 22, 1893...	40	75	39 18 21	72 23 00	6	.....
Aug. 22, 1893...	41	64	39 19. 00	72 34 30	.....	.....
Trip 5:						
Sept. 21, 1893...	42	68	40 04 00	71 25 00	.....	.....
Sept. 21, 1893...	43	78	40 07 30	71 14 00	.....	.....
Sept. 22, 1893...	44	65	40 12 00	71 10 00	.....	.....
Sept. 22, 1893...	45	80	40 14 30	71. 01 00	.....	.....

*Ovaries of fish fully developed.

†Spawn in advanced stage.

During 1894, 1895, and 1896 the *Grampus* and *Fish Hawk* were engaged with other work, and it was the general opinion that, although scattered specimens of the tilefish might be found, they were not sufficiently abundant to warrant continued efforts toward their capture.

On February 8, 1897, the 78-ton schooner *Mabel Kenniston* was overtaken by a gale while on the Georges Bank, and was blown to the westward about 120 miles. The exact location is not definitely known, but it was about 140 miles southwest of No Man's Land, in latitude about 39° 40' N. and longitude 72° 10' W. Haddock trawls

to the westward, as far as the season and the finances of the Commission would permit, in order to verify the facts and see whether the conditions of the theory which I had advanced really seemed to hold good along the southwestern projection of the continental platform. As this conference took place on the *Grampus* and no instructions aside from the verbal understanding between us are in existence, the mere fact that such work was done at that time and under my direction can hardly be explained in any other way.

"With reference to the other question, that in 1893 no tilefish were found near the seventy-first meridian, while a large number were taken near 72° 30' W., 39° 20' N., this would tend, in my opinion, to confirm this statement, because the location which you have given would seem to show that, if not a permanent break in this Hudson River depression, at least a temporary break had occurred. Some fish must have gone across this break, because we found the proper temperatures and proper conditions all around the sides of this depression in 1892. The warm water may have withdrawn slightly, so as to interrupt the movement of the school of fish along the bottom after that time.

"The answers to your questions all hang together upon the establishment of that one point, and here I think I have temperature observations enough to warrant me in the statement that while we did find the tilefish over the whole area in 1892, it is quite probable that the general conditions had not become permanent along the edge of the continental platform, but that they were still undergoing a species of oscillation. It is my impression that if we have a series of years, in the near future, with a predominance of northwesterly winds, we will be treated sooner or later to a new disappearance or annihilation of that same body of fish, because you will easily see that if the warm band representing the lower layers of the Gulf Stream is ever withdrawn from the continental edge, it will probably be withdrawn in the manner in which I have indicated, and then the conditions for the disappearance of the fish will be at hand once more."

set in 65 fathoms of water, when brought to the surface, yielded a catch of 30 tilefish, weighing from 6 to 15 pounds apiece. These were landed in Gloucester on February 16, where they were distributed, and those who ate them stated that they were "better than salmon." The captain of the *Mabel Kenniston* thought the catch of tilefish would have been considerably larger had it not been that the dogfish were very abundant and troublesome.

In August, 1898, the *Grampus* was placed at the disposal of the Director of the Biological Laboratory of the United States Fish Commission at Woods Hole, and a small party of naturalists, quite ignorant of the catch that had been made by the *Mabel Kenniston* in 1897, boarded the vessel on August 12, for the purpose of examining the surface fauna in the warmer waters of the Gulf Stream, and to make a trial for the tilefish, although the apparatus for the latter work was crude and unsatisfactory. At noon on the 13th of August a trawl was set in 70 fathoms of water in latitude $40^{\circ} 11' N.$ and longitude $70^{\circ} 48' W.$ After it had been on the bottom not more than an hour, it was drawn, and 8 tilefish were taken; fully a third of the hooks had been torn away from the rotten gangings. The capture of these 8 tilefish was a most welcome surprise to those on board of the boat, because the trawl that had been used was in a miserable condition, and baited with squeteague, which are unsuited for this method of fishing. Moreover, the line rested on the bottom but a comparatively short time. The boat was immediately headed for Woods Hole to obtain the necessary equipment for a more careful survey of the tilefish grounds.

The locality that had been thus examined was about 10 miles to the eastward of the position occupied by the *Grampus* in 1892, where McDonald and Libbey had caught the first fishes since the mortality of 1882. It was, however, a spot that had not been examined by the vessels that had searched for the tilefish during the intervening years.

Commissioner George M. Bowers very willingly provided the necessary apparatus for a more thorough examination of the tilefish ground, and on the 30th of August the *Grampus* left Woods Hole, sailed to Newport, where two barrels of small mackerel were taken on board for bait, and early on the morning of August 31 two trawls were set in 75 fathoms of water in latitude $40^{\circ} 08' N.$, longitude $71^{\circ} 12' W.$ This was a point about 20 miles to the westward of the location at which the fish were found on August 13, but when the trawl was drawn and the dory had returned to the boat, 7 beautiful tilefish were thrown on to the deck of the *Grampus*. With these were two large skates, two squid, and a small hake. Two trawls, each 200 fathoms in length, were used, and each trawl was provided with 300 hooks. The tilefish were all caught on hooks that had been baited with mackerel. The skates were taken on hooks that had been baited with squeteague.

The boat then ran a few miles to the eastward and the trawls, again baited with mackerel, were set in 75 fathoms. After remaining out for a few hours they were hauled, and from the deck of the *Grampus* we could see the sailors tugging at the line and rolling the great fish over into the boat. When the dory came alongside, the men threw 47 beautiful tilefish on the deck. This was the greatest catch since the mortality of 1882, and proved conclusively that the animal was reestablished in its former habitat.

There was time before dark for the trawls to be set again, although they could remain out but a short time; 19 additional fish, however, were taken, making a total of 73 for the entire day. Although many were young fish weighing less than 2 pounds,

several were over 20 pounds in weight. The presence of large numbers of young fish is of considerable biological importance, for it indicates that the fish are breeding, and that those now found on the old tilefish ground are not there as a result of migration.

On the following day, September 1, three sets were made, yielding 78 fish, and as the bait was now exhausted, the *Grampus* headed for Montauk Point for the purpose of distributing her fare to the soldiers at Camp Wickoff.

After returning from Camp Wickoff, the *Grampus* was delayed at Woods Hole until the latter part of the month. On September 28 Captain Hahn set sail for the edge of the Gulf Stream, with instructions to find, if possible, the eastern limit of distribution of the tilefish. On September 29 he set two tubs of trawl in latitude $40^{\circ} 01' N.$, longitude $69^{\circ} 54' W.$, in 77 fathoms. The trawls were allowed to remain out $2\frac{1}{2}$ hours, and when hauled 61 tilefish, 1 dogfish, 12 skate, and 3 eels were taken. At 10 a. m. on the same day the lines were set some 8 miles to the eastward, and, after 3 hours, 59 tilefish, 100 dogfish, and 2 skate were captured. At 3 p. m. 3 tubs of trawl were set about 5 miles farther to the eastward, in 72 fathoms of water, and remained out for $2\frac{1}{2}$ hours. While this set was being drawn into the dory unfortunately the line parted, and presumably half the fish were lost. It was dark and the outer buoy could not be located. The fragment of line contained 38 tilefish, and nearly every hook not occupied by a tilefish had caught a dogfish; indeed, the great number and weight of the dogfish accounted for the parting and loss of the line.

On the morning of September 30 a trawl was set in 76 fathoms, latitude $40^{\circ} 03' N.$, longitude $69^{\circ} 16' W.$ It was out 3 hours, and when drawn into the dory 19 tilefish, 2 skate, and 4 hake were taken. At this time only $1\frac{1}{2}$ tubs of trawl were used, about 550 hooks. Still farther to the east, at station 12, only 14 tilefish were taken, and, at the easternmost station, $40^{\circ} 05' N.$, $69^{\circ} 06' W.$, only 12 tilefish were caught, $1\frac{1}{2}$ tubs of trawl line being used.

It would appear from these figures that Captain Hahn had found the eastern boundary of the tilefish "bank," near the sixty-ninth meridian, although even at his last trial several large fish were taken.

This was the last excursion for tilefish made in 1898, and it may be safe to conclude that, inasmuch as on every occasion that the trawl was set in water of appropriate depth the tilefish were found, their area of distribution probably extends from 69° to 73° west longitude, and along a band of the sea bottom of varying width, and from 70 to 80 fathoms in depth, although no tests were made in deeper water.

A tabulated statement of the localities which were examined follows:

Date.	Station No.	Depth.	Lat. N.	Long. W.	No. of tilefish.	Weight.
Trip 1:		<i>Fms.</i>	° "	° "		<i>Lbs.</i>
Aug. 13, 1898...	1	75	40 11 00	71 48 00	8	.....
Trip 2:						
Aug. 31, 1898...	2	75	40 08 00	71 12 45	7	.....
Aug. 31, 1898...	3	75	40 12 00	71 05 00	47	350 ⁺
Aug. 31, 1898...	4	75	40 11 15	71 03 45	19	74
Sept. 1, 1898...	5	80	40 14 15	71 00 15	24	80 ⁺
Sept. 1, 1898...	6	.....	40 15 30	70 55 45	39	825 ⁺
Sept. 1, 1898...	7	.....	40 10 00	70 54 30	15	138
Trip 3:						
Sept. 29, 1898...	8	77	40 01 00	69 54 30	61	658
Sept. 29, 1898...	9	71	40 04 00	69 45 30	59	825
Sept. 29, 1898...	10	72	40 04 00	69 39 00	38	422
Sept. 30, 1898...	11	76	40 03 00	69 16 00	10	214
Sept. 30, 1898...	12	70	40 04 30	69 11 00	14	96
Sept. 30, 1898...	13	75	40 05 30	69 06 00	12	120
Oct. 1, 1898...	14	60	40 10 00	69 50 00	.....	.....

Measurements of weight and length of fish caught during the excursions of 1898 are recorded here, since they may form a basis for estimating the rate of growth during succeeding years:

Weight and length of tilefish taken in 1898.

Date.	Station No.	Fish No.	Length.	Weight.	Date.	Station No.	Fish No.	Length.	Weight.
			<i>Inches.</i>	<i>Pounds.</i>				<i>Inches.</i>	<i>Pounds.</i>
Aug. 13.	1	1			Aug. 31.	4	12	22.50	3.75
Aug. 13.	1	2			Aug. 31.	4	13	23.50	5
Aug. 13.	1	3			Aug. 31.	4	14	24	4.50
Aug. 13.	1	4			Aug. 31.	4	15	24.50	6
Aug. 13.	1	5			Aug. 31.	4	16	25.50	5.50
Aug. 13.	1	6			Aug. 31.	4	17	29	10.50
Aug. 13.	1	7			Aug. 31.	4	18	31	12
Aug. 13.	1	8			Aug. 31.	4	19	33	14
Aug. 31.	2	1	12.75		Sept. 1.	5	1	13	.50
Aug. 31.	2	2	13		Sept. 1.	5	2	13	.50
Aug. 31.	2	3	13.25		Sept. 1.	5	3	13.50	.50
Aug. 31.	2	4	13.75		Sept. 1.	5	4	13.50	.50
Aug. 31.	2	5	14		Sept. 1.	5	5	13.50	.50
Aug. 31.	2	6	14		Sept. 1.	5	6	13.75	.50
Aug. 31.	2	7	15.75		Sept. 1.	5	7	13.75	.50
Aug. 31.	3	1	17	1.50	Sept. 1.	5	8	14	.50
Aug. 31.	3	2	17	1.50	Sept. 1.	5	9	14	.50
Aug. 31.	3	3	17.25	1.75	Sept. 1.	5	10	14	.50
Aug. 31.	3	4	17.25	1.75	Sept. 1.	5	11	14	.50
Aug. 31.	3	5	17.50	1.75	Sept. 1.	5	12	14	.50
Aug. 31.	3	6	17.50	1.50	Sept. 1.	5	13	14.50	.75
Aug. 31.	3	7	17.50	1.75	Sept. 1.	5	14	17.25	1.75
Aug. 31.	3	8	17.50	1.50	Sept. 1.	5	15	17.50	1.75
Aug. 31.	3	9	18	2	Sept. 1.	5	16	17.50	1.75
Aug. 31.	3	10	18	2	Sept. 1.	5	17	17.75	1.375
Aug. 31.	3	11	18	2	Sept. 1.	5	18	18	1.75
Aug. 31.	3	12	18	2	Sept. 1.	5	19	18.75	2
Aug. 31.	3	13	18	1.75	Sept. 1.	5	20	20.75	3.50
Aug. 31.	3	14	18	1.50	Sept. 1.	5	21	23.75	5.50
Aug. 31.	3	15	18	1.75	Sept. 1.	5	22	29	11.50
Aug. 31.	3	16	18	2	Sept. 1.	5	23	29.50	12
Aug. 31.	3	17	18.25	2	Sept. 1.	5	24	33.50	20
Aug. 31.	3	18	22.50	5	Sept. 1.	6	1	17	1.50
Aug. 31.	3	19	23	5	Sept. 1.	6	2	18	1.75
Aug. 31.	3	20	23	4.75	Sept. 1.	6	3	18	1.75
Aug. 31.	3	21	23	5	Sept. 1.	6	4	18.25	2
Aug. 31.	3	22	23	5	Sept. 1.	6	5	18.75	2
Aug. 31.	3	23	23	5	Sept. 1.	6	6	19	2
Aug. 31.	3	24	23	4.50	Sept. 1.	6	7	20.75	3
Aug. 31.	3	25	23.25	4.50	Sept. 1.	6	8	21	2.50
Aug. 31.	3	26	23.50	5	Sept. 1.	6	9	22.75	5
Aug. 31.	3	27	23.50	4.75	Sept. 1.	6	10	22.75	5
Aug. 31.	3	28	24	5	Sept. 1.	6	11	23.25	5.50
Aug. 31.	3	29	24	5.50	Sept. 1.	6	12	23.50	4.75
Aug. 31.	3	30	24	5.50	Sept. 1.	6	13	23.50	4.75
Aug. 31.	3	31	25	7.50	Sept. 1.	6	14	24	5.50
Aug. 31.	3	32	25	7	Sept. 1.	6	15	24	6
Aug. 31.	3	33	26		Sept. 1.	6	16	24.50	5.50
Aug. 31.	3	34	26	7.50	Sept. 1.	6	17	24.75	6.50
Aug. 31.	3	35	26	7	Sept. 1.	6	18	25	8
Aug. 31.	3	36	26	8	Sept. 1.	6	19	25	6.25
Aug. 31.	3	37	28	9.50	Sept. 1.	6	20	25	7
Aug. 31.	3	38	28	10	Sept. 1.	6	21	26	8
Aug. 31.	3	39	29	19	Sept. 1.	6	22	26	8
Aug. 31.	3	40	33	21.50	Sept. 1.	6	23	26.50	6.50
Aug. 31.	3	41	34	20	Sept. 1.	6	24	26.50	8
Aug. 31.	3	42	34	19.50	Sept. 1.	6	25	26.50	9
Aug. 31.	3	43	34	19.50	Sept. 1.	6	26	26.50	9
Aug. 31.	3	44	34	19	Sept. 1.	6	27	28	10
Aug. 31.	3	45	34	18	Sept. 1.	6	28	28.75	10.50
Aug. 31.	3	46	34.50	22	Sept. 1.	6	29	29	11
Aug. 31.	3	47	34.50	20	Sept. 1.	6	30	29	11
Aug. 31.	4	1	13.50	.50	Sept. 1.	6	31	29.25	11
Aug. 31.	4	2	15	.50	Sept. 1.	6	32	29.75	12
Aug. 31.	4	3	16	.50	Sept. 1.	6	33	33	0
Aug. 31.	4	4	17.50	1.75	Sept. 1.	6	34	33	20
Aug. 31.	4	5	18	1.50	Sept. 1.	6	35	34	22.50
Aug. 31.	4	6	18.50	1.75	Sept. 1.	6	36	34	22
Aug. 31.	4	7	19	2	Sept. 1.	6	37	34	21
Aug. 31.	4	8	19	1.375	Sept. 1.	6	38	34.50	21
Aug. 31.	4	9	19	1.75	Sept. 1.	6	39	35	22
Aug. 31.	4	10	19.50	1.75	Sept. 1.	7	1	17	1.50
Aug. 31.	4	11	19.50	1.25	Sept. 1.	7	2	17.50	1.75

THE REAPPEARANCE OF THE TILEFISH.

Weight and length of tilefish taken in 1898—Continued.

Date.	Station No.	Fish No.	Length.	Weight.	Date.	Station No.	Fish No.	Length.	Weight.
			<i>Inches.</i>	<i>Pounds.</i>				<i>Inches.</i>	<i>Pounds.</i>
Sept. 1.....	7	3	22	4.75	Sept. 29.....	9	9	26	9
Sept. 1.....	7	4	22.50	4.50	Sept. 29.....	9	10	26	11
Sept. 1.....	7	5	24	6	Sept. 29.....	9	11	26	10
Sept. 1.....	7	6	24	5	Sept. 29.....	9	12	26	9
Sept. 1.....	7	7	24.50	6.50	Sept. 29.....	9	13	26	9
Sept. 1.....	7	8	24.50	7	Sept. 29.....	9	14	27	10
Sept. 1.....	7	9	25	7.50	Sept. 29.....	9	15	27	11
Sept. 1.....	7	10	25	6	Sept. 29.....	9	16	27	10
Sept. 1.....	7	11	28	9.75	Sept. 29.....	9	17	27	10
Sept. 1.....	7	12	28.50	10.50	Sept. 29.....	9	18	27	9
Sept. 1.....	7	13	31.50	15	Sept. 29.....	9	19	27	9
Sept. 1.....	7	14	33	19	Sept. 29.....	9	20	27	12
Sept. 1.....	7	15	33.50	20	Sept. 29.....	9	21	27	9
Sept. 29.....	8	1	13	1	Sept. 29.....	9	22	27	11
Sept. 29.....	8	2	13	1	Sept. 29.....	9	23	27	11
Sept. 29.....	8	3	13	1	Sept. 29.....	9	24	27	10
Sept. 29.....	8	4	14	9	Sept. 29.....	9	25	27	9
Sept. 29.....	8	5	14	1	Sept. 29.....	9	26	28	11
Sept. 29.....	8	6	17	24	Sept. 29.....	9	27	28	12
Sept. 29.....	8	7	17	2	Sept. 29.....	9	28	28	10
Sept. 29.....	8	8	17	2	Sept. 29.....	9	29	28	10
Sept. 29.....	8	9	17	2	Sept. 29.....	9	30	29	9
Sept. 29.....	8	10	18	2	Sept. 29.....	9	31	29	10
Sept. 29.....	8	11	20	9	Sept. 29.....	9	32	29	9
Sept. 29.....	8	12	21	3	Sept. 29.....	9	33	29	10
Sept. 29.....	8	13	22	5	Sept. 29.....	9	34	30	12
Sept. 29.....	8	14	23	1	Sept. 29.....	9	35	30	9
Sept. 29.....	8	15	24	27	Sept. 29.....	9	36	30	12
Sept. 29.....	8	16	24	10	Sept. 29.....	9	37	30	10
Sept. 29.....	8	17	24	8	Sept. 29.....	9	38	30	12
Sept. 29.....	8	18	25	7	Sept. 29.....	9	39	30	11
Sept. 29.....	8	19	26	10	Sept. 29.....	9	40	30	10
Sept. 29.....	8	20	26	8	Sept. 29.....	9	41	30	11
Sept. 29.....	8	21	26	10	Sept. 29.....	9	42	31	10
Sept. 29.....	8	22	26	9	Sept. 29.....	9	43	31	23
Sept. 29.....	8	23	26	11	Sept. 29.....	9	44	31	11
Sept. 29.....	8	24	26	9	Sept. 29.....	9	45	33	20
Sept. 29.....	8	25	26	6	Sept. 29.....	9	46	33	20
Sept. 29.....	8	26	26	11	Sept. 29.....	9	47	33	22
Sept. 29.....	8	27	26	10	Sept. 29.....	9	48	35	21
Sept. 29.....	8	28	26	10	Sept. 29.....	9	49	35	22
Sept. 29.....	8	29	27	5	Sept. 29.....	9	50	36	21
Sept. 29.....	8	30	27	11	Sept. 29.....	9	51	36	23
Sept. 29.....	8	31	27	7	Sept. 29.....	9	52	36	24
Sept. 29.....	8	32	27	20	Sept. 29.....	9	53	36	27
Sept. 29.....	8	33	27	16	Sept. 29.....	9	54	36	22
Sept. 29.....	8	34	27	10	Sept. 29.....	9	55	36	26
Sept. 29.....	8	35	27	11	Sept. 29.....	9	56	38	24
Sept. 29.....	8	36	27	9	Sept. 29.....	9	57	38	27
Sept. 29.....	8	37	27	11	Sept. 29.....	9	58	39	29
Sept. 29.....	8	38	28	12	Sept. 29.....	9	59	40	26
Sept. 29.....	8	39	28	10	Sept. 29.....	10	1	15	1
Sept. 29.....	8	40	28	2	Sept. 29.....	10	2	16	1
Sept. 29.....	8	41	28	11	Sept. 29.....	10	3	19	3
Sept. 29.....	8	42	28	13	Sept. 29.....	10	4	20	2
Sept. 29.....	8	43	28	18	Sept. 29.....	10	5	21	8
Sept. 29.....	8	44	28	13	Sept. 29.....	10	6	23	6
Sept. 29.....	8	45	29	11	Sept. 29.....	10	7	23	6
Sept. 29.....	8	46	30	10	Sept. 29.....	10	8	24	10
Sept. 29.....	8	47	30	15	Sept. 29.....	10	9	24	10
Sept. 29.....	8	48	30	16	Sept. 29.....	10	10	25	8
Sept. 29.....	8	49	30	15	Sept. 29.....	10	11	26	9
Sept. 29.....	8	50	31	4	Sept. 29.....	10	12	26	11
Sept. 29.....	8	51	31	15	Sept. 29.....	10	13	27	9
Sept. 29.....	8	52	32	19	Sept. 29.....	10	14	27	9
Sept. 29.....	8	53	32	21	Sept. 29.....	10	15	27	10
Sept. 29.....	8	54	33	18	Sept. 29.....	10	16	27	10
Sept. 29.....	8	55	33	9	Sept. 29.....	10	17	27	9
Sept. 29.....	8	56	33	10	Sept. 29.....	10	18	27	10
Sept. 29.....	8	57	33	25	Sept. 29.....	10	19	27	10
Sept. 29.....	8	58	34	15	Sept. 29.....	10	20	27	11
Sept. 29.....	8	59	35	26	Sept. 29.....	10	21	27	9
Sept. 29.....	8	60	35	24	Sept. 29.....	10	22	27	10
Sept. 29.....	8	61	36	22	Sept. 29.....	10	23	28	10
Sept. 29.....	9	1	10	26	Sept. 29.....	10	24	28	11
Sept. 29.....	9	2	24	9	Sept. 29.....	10	25	28	11
Sept. 29.....	9	3	24	9	Sept. 29.....	10	26	29	12
Sept. 29.....	9	4	25	9	Sept. 29.....	10	27	29	12
Sept. 29.....	9	5	25	9	Sept. 29.....	10	28	29	13
Sept. 29.....	9	6	26	10	Sept. 29.....	10	29	30	14
Sept. 29.....	9	7	26	9	Sept. 29.....	10	30	30	14
Sept. 29.....	9	8	26	9	Sept. 29.....	10	31	31	15

Weight and length of tilefish taken in 1898—Continued.

Date.	Station No.	Fish No.	Length.	Weight.	Date.	Station No.	Fish No.	Length.	Weight.
			<i>Inches.</i>	<i>Pounds.</i>				<i>Inches.</i>	<i>Pounds.</i>
Sept. 29.....	10	32	31	16	Sept. 30.....	12	1	15	2
Sept. 29.....	10	33	33	16	Sept. 30.....	12	2	18	2
Sept. 29.....	10	34	33	19	Sept. 30.....	12	3	18	2
Sept. 29.....	10	35	34	19	Sept. 30.....	12	4	18	2
Sept. 29.....	10	36	34	24	Sept. 30.....	12	5	18	2
Sept. 29.....	10	37	35	22	Sept. 30.....	12	6	21	5
Sept. 29.....	10	38	36	23	Sept. 30.....	12	7	25	7
Sept. 30.....	11	1	16	2	Sept. 30.....	12	8	26	12
Sept. 30.....	11	2	18	2	Sept. 30.....	12	9	26	9
Sept. 30.....	11	3	24	12	Sept. 30.....	12	10	27	9
Sept. 30.....	11	4	24	6	Sept. 30.....	12	11	28	10
Sept. 30.....	11	5	27	10	Sept. 30.....	12	12	28	10
Sept. 30.....	11	6	27	11	Sept. 30.....	12	13	29	11
Sept. 30.....	11	7	27	9	Sept. 30.....	12	14	30	13
Sept. 30.....	11	8	27	9	Sept. 30.....	13	1	13	1
Sept. 30.....	11	9	27	8	Sept. 30.....	13	2	14	1
Sept. 30.....	11	10	27	9	Sept. 30.....	13	3	16	2
Sept. 30.....	11	11	27	10	Sept. 30.....	13	4	18	2
Sept. 30.....	11	12	27	12	Sept. 30.....	13	5	27	10
Sept. 30.....	11	13	27	11	Sept. 30.....	13	6	27	11
Sept. 30.....	11	14	28	10	Sept. 30.....	13	7	29	12
Sept. 30.....	11	15	29	11	Sept. 30.....	13	8	29	13
Sept. 30.....	11	16	30	13	Sept. 30.....	13	9	30	13
Sept. 30.....	11	17	36	26	Sept. 30.....	13	10	30	13
Sept. 30.....	11	18	36	19	Sept. 30.....	13	11	30	15
Sept. 30.....	11	19	36	24	Sept. 30.....	13	12	36	27

Following are abstracts of some recent letters concerning the food qualities of the tilefish:

[From Mr. H. R. Storer, Providence, R. I.]

The tilefish was boiled for dinner, and what was left therefrom warmed with cream for breakfast the next morning. Both dishes proved delicious, even more so than cod, which is my favorite. I sent a portion of the fish to my neighbor, Mr. Benj. R. Smith, and his family gave an equally satisfactory report.

[From Mr. W. P. Titcomb, Washington, D. C.]

Regarding the sample of the tilefish with which you favored me last week, I have to say that I rate it as equal in texture and flavor to any salt-water fish, except the mackerel, which of course will not bear transportation and retain its flavor as the tilefish evidently does. Although very fond of halibut, and rating it very highly, I am inclined to think from this, the only sample of tilefish which I have tasted, that I should regard it as equally desirable.

[From Mr. Lucian D. Sharpe, II, Providence, R. I.]

I wish to acknowledge the fine tilefish you were kind enough to send us. We enjoyed it very much, and the flesh was quite fine and sweet, though with not as much flavor as some fish have.

[From Mr. Nathan Babcock, Westerly, R. I.]

Through the kindness of Mr. J. A. Ripple I had a sample of the "tile," the rediscovered fish. I think it is an excellent fish. It far surpasses the cod. It is delicate in flavor, and in all respects very palatable. It will find favor with those who enjoy good fish.

[From Mr. J. M. K. Southwick, Newport, R. I.]

I promised you a report on the tilefish. Briggs thinks it rather dry and tasteless. H. Christian thought it very good. Charles Clark baked his and liked it very much. J. I. Wright boiled his and says it was excellent; knew no fish he liked better; thought it very good, better than cod. Edw. Lilley thought it very nice. Capt. J. V. Cotton says it was between a cod and a halibut. The writer boiled his and remarked the same lack of taste noted by Briggs, but juicy, not dry. I consider it a very valuable edible fish.

[From Mr. John F. Calkins, Providence, R. I.]

Tilefish is good. Boiled, first class; broiled, fair; made into a salad, excellent. I think that with proper preparation it would be good baked. Of course, like all fish, the fresher the better. I see no reason why it should not become a valuable addition to our list of food-fishes. It should not be boiled one moment beyond the point of "done." I noted plenty of gelatine in it.

[From Messrs. Johnson & Smith, Boston, Mass.]

Yours in regard to the tilefish received, asking our opinion of it. We found it to be a good fish for eating, having a fine flavor, resembling that of our striped bass or what they call in Washington rockfish. It has also lasting qualities, remaining in good condition for several days, which is greatly in its favor. We hope that we may soon have more of it.

[From Hon. Eugene G. Blackford, New York, N. Y.]

In reply to your favor of the 20th, permit me to say that I consider the tile an excellent table fish. The flesh is somewhat coarse, but very sweet, and I should say that it more nearly resembles the blackfish or tautog than any other fish I can recall. I should recommend to those testing its edible qualities to have it baked and served with a brown sauce.

Out of the fish that you sent as an experiment to this market I selected some for a dinner at the Union Club of this city—the most prominent of all our clubs. The fish was served to about twenty-five gentlemen, nearly all of whom might be considered gastronomical experts, and they were all delighted with it. I may say parenthetically that the fish were at least a week old when they were served, so that I question whether the best possible results were obtained from the test of their edible qualities.